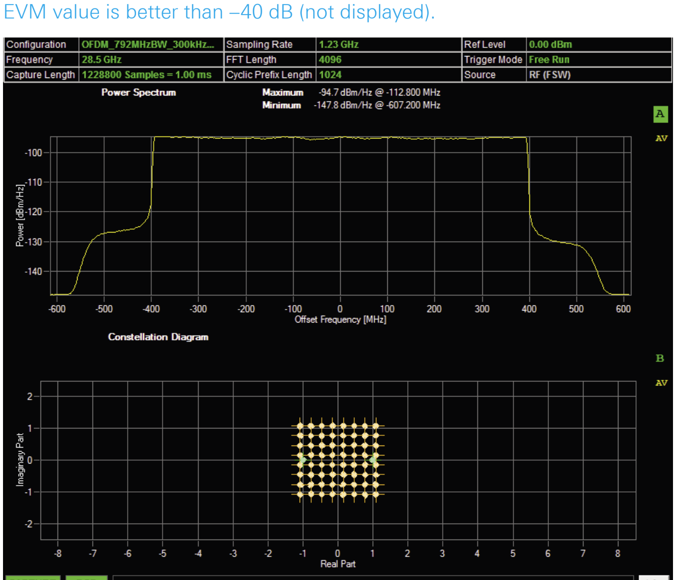
Wideband amplifier measurements for 5G with up to 1.2 GHz analysis bandwidth

The extended analysis bandwidth of 1.2 GHz for the R&S®FSW signal and spectrum analyzer makes it possible to carry out demanding measurements on components for the future 5G cellular standard. Additional measurement options are available to comprehensively characterize amplifiers and analyze OFDM-modulated signals.

To surpass the data rates of the current LTE technology with the future 5G cellular standard, the industry is focusing on frequency bands in the microwave range, including at 28 GHz and 39 GHz. Bundling multiple carriers makes it possible to achieve bandwidths of several hundred megahertz, for example 800 MHz with eight carriers of 100 MHz. 5G component developers, therefore, require a T&M solution to analyze signals of these frequencies and bandwidths.

The new R&S®FSW-B1200 option expands the analysis bandwidth of the R&S®FSW signal and spectrum analyzer to 1.2 GHz. It offers a high dynamic range and low input signal distortion, with a spurious free dynamic range (SFDR) of 65 dBc. These characteristics allow users to precisely determine the signal modulation quality, e.g. by measuring the error vector magnitude (EVM). The EVM generated by the instrument itself must be minimal to ensure reliable measurements on signals with very good EVM. For example, the bandwidth extension and the R&S®FS-K96PC OFDM vector signal analysis software allow the R&S®FSW to measure EVM values in the order of –40 dB with 800 MHz wide signals in the 28 GHz range (Fig. 1). The OFDM analysis software enables users to measure modulation also on non-standardized OFDM signals and offers a high degree of freedom in defining the measurement parameters for the OFDM demodulator. This flexibility provides a tremendous advantage, as the specification of OFDM signals has not yet been finalized in the future 5G cellular standard.

Fig. 1: Analysis of an 800 MHz wide OFDM signal at 28 GHz with the R&S®FSW-B1200 1.2 GHz analysis bandwidth option and the R&S®FS-K96PC OFDM vector signal analysis software. The measured EVM value is better than –40 dB (not displayed).



Digital predistortion compensates for nonlinear effects in amplifiers

Power amplifiers in base stations and smartphones must exhibit a high degree of linearity over a wide frequency range to offer good transmit and receive characteristics. Unwanted nonlinear effects, however, generally occur in the upper power range and diminish signal quality. They manifest themselves as higher EVM values and increased interference in adjacent channels. As a result, only lower orders of modulation and, consequently, lower data rates can be achieved. By characterizing these effects, it is possible to compensate for them using digital predistortion.

The R&S®FSW-K18 amplifier measurements option and its extension, the R&S®FSW-K18D direct DPD measurements option, enable developers to determine the extent to which predistortion can compensate for nonlinear effects in an amplifier design. These options can be used to characterize distortion caused by nonlinear amplitude and/or phase changes relative to the input signal (AM/AM and AM/φM) and compensate for it mathematically by applying various methods. R&S®FSW-K18 initially compares a reference signal from a vector signal generator against the signal amplified by the device under test. The software then calculates a correction polynomial that describes predistortions by way of approximation. The software can also use an equalizer to calculate the frequency response. Analysis bandwidths that are triple, quadruple and quintuple the signal bandwidth are typi-

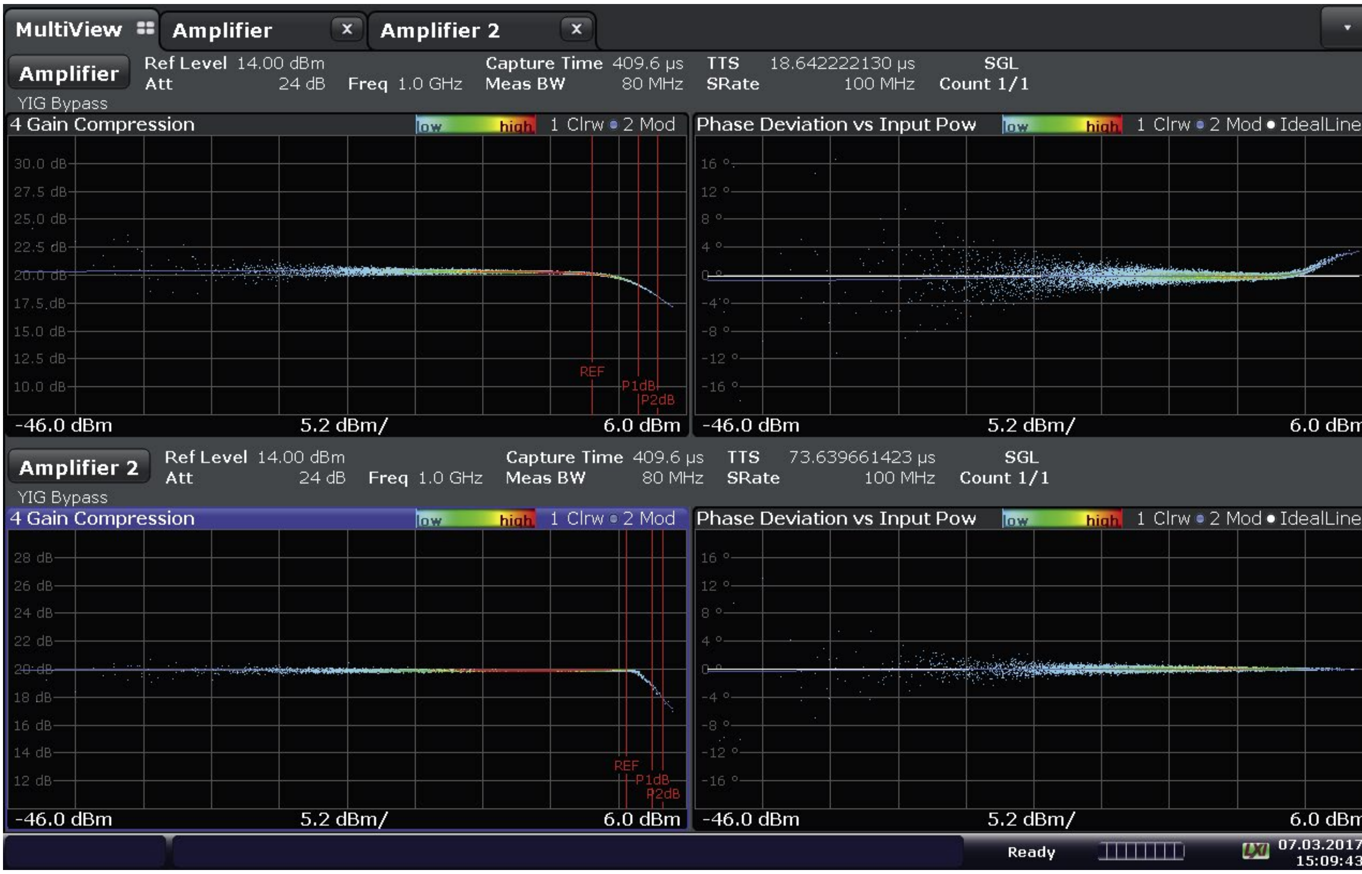


Fig. 2: Diagrams at the top: A signal distorted by an amplifier. The amplifier goes into compression when the power is increased (at approx. 1 dBm). Amplification is no longer linear and the phase is distorted. Diagrams at the bottom: A signal predistorted with correction data from the R&S®FSW. Compression starts at a significantly higher power level. The 1 dB compression point is approx. 1 dB higher, and the phase distortion is corrected perfectly. Correcting memory effects with the R&S®FSW-K18D option also reduces the scattering of test points; the displayed traces are narrower.

cally used to incorporate interference interspersed in adjacent channels. R&S®FSW-K18 sends the calculated amplitude and phase correction values to the R&S®SMW200A vector signal generator. The generator uses these values to predistort a signal, which is applied to the DUT. The R&S®FSW measures and displays the output signal from the DUT (Fig. 2). At this point, the output signal has as little distortion as the amplifier design and correction method will allow.

In addition to nonlinear effects, memory effects in the amplifier produce a frequency response that cannot be corrected using polynomials. In the past, elaborate mathematics such as Volterra series were required to describe this response. The R&S®FSW-K18D extension to the R&S®FSW-K18 amplifier measurements option now simplifies compensation. Instead of approximation through polynomials, R&S®FSW-K18D applies iterative approximation via the individual samples. In this way, the software compensates both nonlinear distortion and frequency response for a predefined signal sequence. The result delivers the best possible reference for predistortion algorithms employed by the user. The 1.2 GHz analysis bandwidth now available in the R&S®FSW makes it possible to characterize amplifiers with a bandwidth up to approx. 1 GHz.

Summary

An analysis bandwidth of 1.2 GHz is now available for the R&S®FSW43 and R&S®FSW50 high-end signal and spectrum analyzers. It can be used across the entire frequency range of the analyzers, making them particularly suitable for measurements in the frequency bands relevant to 5G. The R&S®FSW-K18D direct DPD measurements extension to the R&S®FSW-K18 amplifier measurements option now also makes it possible to compensate for memory effects in amplifiers.

The R&S®FSW now supports 2 GHz with the R&S®FSW-B2000 option for applications requiring more than 1.2 GHz analysis bandwidth. The option uses an R&S®RTO oscilloscope as an external analog-to-digital converter and can be applied with center frequencies from 5.5 GHz.

Martin Schmähling